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ABSTRACT

In educational and training environments, teachers assign their students independent research tasks that require locating, gathering, synthesizing, and summarizing information from one or more information resources containing large, and sometimes overwhelming, amounts of information. This study explored the information location and use activities, motivation, and learning patterns of children and adults using either a print or a multimedia resource to complete a research task. A group of 89 middle school students and a group of 36 adult graduate students served as subjects for the study and were assigned a multimedia treatment or a print treatment. The topic of the materials used in the study was the life and art of Vincent Van Gogh. Subjects were given 30 minutes to gather information from the assigned resource (either book or multimedia). Researchers recorded information location and use strategies on an observation checklist. A motivation questionnaire was used to evaluate subjects' motives and values related to the resource used. A pattern noting technique was utilized to assess prior knowledge and learning outcomes. Results indicated some differences in engagement of text and non-text information; expectancy of success; and type of knowledge representation. (Contains 30 references.) (JLB)

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Title:

Multimedia vs. Print Information Resources: Information Location and Use, Motivation, and Learning Patterns for Children and Adults

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ABSTRACT

In educational and training environments teachers assign their students independent research tasks that require locating, gathering, synthesizing, and summarizing information from one or more information resources containing large, and sometimes overwhelming, amounts of information. Often these tasks are poorly-defined, requiring learners to utilize resources that have not been tailored to meet their specific information needs. This may result in information overload and/or information anxiety. This study explored the information location and use activities, motivation and learning patterns of children and adults using either a print or multimedia resource to complete a research task. Results indicated some differences in engagement of text and nontext information, expectancy of success, and type of knowledge representation.

INTRODUCTION

Although there have been numerous studies comparing learning and performance with various instructional delivery systems, their results have been largely mixed (e.g. Clark, 1983). In addition, many of these studies center on a medium as an *instructional* rather than *informational* intervention to satisfy a learning need. Furthermore, research questions focus on whether one medium is better (i.e. results in higher learning and/or motivation outcomes) than another medium, rather than examining how learning occurs with a specific information resource.

In educational and training environments students may be assigned independent research tasks that require them to locate, gather, synthesize, and summarize information from one or more information resources containing large, and sometimes overwhelming, amounts of information. Often these tasks are poorly-defined, requiring learners to utilize resources that have not been tailored to meet their specific information needs. Furthermore, students even as young as elementary and middle school age, are often expected to accomplish the major part of a research task independently (Kuhlthau, 1989). In addition, they may use multimedia information resources that require the processing of both print and non-print information simultaneously.

These issues become magnified as the use of information technologies (both stand-alone and distributed) allow students to gain access to information in contexts that are outside of traditional structured educational institutions (e.g. homes). This may result in information overload and "information anxiety," described by Wurman (1989) as a" black hole between data and knowledge" (p. 34). The purpose of this study was to explore the attitudes and processes that students activate when using different types of information resources to complete an independent research task. The study focused on three areas---information location and use, motivation, and learning.

Information Location and Use

Traditionally, students have conducted information retrieval activities by locating relevant print resources (e.g. encyclopedias, reference books), searching through them one at a time, extracting bits of relevant information from each resource. Once they have extracted what they perceive as important information within one resource, they proceed to the next resource and repeat the process. Eisenberg and Berkowitz (1990) describe this process in the context of a larger information problem solving process. In this study we focused on three information *location and use* tasks consist of *finding* desired information within a resource either through using an organizational tool (e.g. index) or browsing (random or sequential), *engaging* the information by viewing, reading and/or listening, and *extracting* information within a resource through notetaking. Marchionini (1989) likens these activities to conducting the look up, examining the results, and extracting relevant information.

Current technologies that combine computer-based control and a CD-ROM or laserdisk storage device provide students with simultaneous access to integrated information resources that utilize a variety of media (Grabowski & Curtis, 1991). Theoretically, these multimedia information resources provide students with faster and easier access to potentially richer bodies of information than any single medium resource. As a result, information skills such as finding, selecting, and extracting become even more critical (Small & Ferreira, in press).

Several studies have investigated information location and use with computer-based and print resources. Mynatt et al. (1992) found that subjects using a hypertext, nonlinear book, even with minimal training, are as successful at an information seeking task as those using a conventional book. Shneiderman (1987) reported about equal performance on an information use task with a hypertext and print version. MacKnight and Baroni (1993) found that students using either print or electronic versions of a manual to complete a

research task did not differ in their ability to recognize and extract important information from either source or in the number of times they bypassed or overlooked important information. The current study investigates differences in information location and use activities (finding, engaging, and extracting by children and adults using a print-based or multimedia resource to complete a research task.

Motivation

The attitudes or motives users harbor in regard to a particular information resource may influence their use of that resource which, in turn, could influence their perceptions about the accessibility of relevant information within that resource (Culnan, 1985). In this study, motivation is defined broadly in terms of the value and expectations of successful use of a resource, a theory known as expectancy-value theory (e.g. Porter & Lawler, 1968). *Value* refers to the perceived importance of or interest in the information resource, while *expectancy* refers to the perceived accessibility of needed information and successful completion of the task.

Taylor (1986) identifies a number of characteristics of an information system (e.g. accessibility, accuracy, currency, reliability, ease-of-use) that add value for the user of that system. For example, the most effectively and efficiently designed encyclopedia would be considered a poor learning resource if it contained inaccurate, outdated, or irrelevant information for meeting a learner's specific information needs.

Previous research indicates that computer-based systems that stimulate curiosity and interest and allow greater user control may result in more positive attitudes, greater engagement in, and less anxiety toward using these systems (Kinzie, 1990). Heroman (1990) found high student engagement to have a positive relationship with satisfaction with an overall learning situation. Stimulation deficit (information underload) or excessive stimulation (information overload) often result in boredom (Klapp, 1986). The learner's perception of his/her competence in successfully navigating this type of system and retrieving all of the relevant information may contribute to a positive motivation toward the system and successful accomplishment of learning goals (Kinzie, 1990). Keller (e.g. 1983) describes instructional motivation in terms of stimulating interest and curiosity and providing relevance, importance, and utility (value-related strategies), building confidence and competence, and promoting satisfaction through effort-success linkages (expectancy-related strategies).

In a study comparing computer-based to print-based instruction, Yang (1991-2) found that the computer-based instructional group showed significantly higher motivation on a post-treatment motivation survey than did the print-based instruction group and concluded that the computer had a strong motivational impact on students' learning, possibly resulting from the novelty and higher potential learner control of that medium.

Much of the current research has determined that students who use computer-based instructional resources are more highly motivated than those using print resources. The current study compared changes in motivation levels for subjects required to use a specific resource to complete a poorly-defined, independent research task where (1) the resource is learner-controlled rather than instructor-controlled and (2) the resource is informational rather than instructional (Grabowski & Curtis, 1991).

Learning Patterns

Studies comparing learning with print and non-print sources, often use traditional methods of evaluation such as multiple choice tests. These are appropriate when the body of content to be learned is tightly controlled, as in a textbook or computer-based instructional program. However, when the task is one in which the learner uses one or more resources which are *informational* rather than *instructional* in nature, the body of content is often not

easily controlled and there is a lack of learning guidance.

Users of multimedia resources may independently select, process, and interrelate new pieces of information with information they already know to construct new knowledge (DeCorte 1990). They enjoy a new sense of empowerment by having control over format, type and amount of information, pace, and sequence of content (Small & Grabowski, 1992).

Regardless of the resource, students seek to find an order, structure and intellectual framework for the information. Wurman (1989) contends that the ways of organizing and structuring information are finite. He has identified five organizational schemes: category, time, location,alphabet, or continuum. A major advantage for the use of multimedia resources is that they are often organized in a way that mimics the associative properties of human memory, facilitating the user's ability to create personalized organizational schemata for the information presented (Jonassen & Wang, 1990). However, a major disadvantage is that without system control and learning guidance, there is a greater danger of users skipping over important information or exiting the system before relevant content is accessed (Milheim & Azbell, 1988).

Attempts to measure learning during research activities in which information access is not tightly controlled defy the use of traditional instruments (e.g. multiple choice tests). May of the studies that compare learning with multimedia or print resources compare *amount of information retained* rather than exploring how learners *cognitively structure learned information*.

Users of multimedia resources may select, store, and organize information in their memories in a variety of ways. They may choose to attend to some information while ignoring other information. This means that methods for assessing both prior knowledge and knowledge acquisition when learning from information sources must be used that "map" the knowledge of users to better understand their cognitive schema. The current study used a technique similar to cognitive mapping known as "pattern noting" (Buzan, 1974) to determine users' prior and subsequent knowledge when using multimedia versus print information resources.

Research Questions

1. What information location and use activities (i.e. finding, engaging, extracting) are utilized when accessing information using a print or multimedia information resource and do they differ due to the age of the learners?

2. Are there differences in motivation (values and expectancies) when completing a research task using print or multimedia resources?

3. In what ways do resulting learning patterns differ when using a print or multimedia resource?

These questions were explored for children using either a print or multimedia resource. Additional data were gathered from adults using the multimedia resource only.

METHODS

Instruments

In order to determine information location and use, motivation, and learning, patterns for subjects using print or multimedia resources, three types of instruments were used.

Observation Checklist. An observation checklist was developed to record information

location and use activities exhibited by subjects for both multimedia and print treatments. These activities corresponded to computer program menu choices or print resource options (e.g. using the index, using the table of contents, random browsing, searching by topic or keyword). In addition, each of these activities was classified according to the information location and use skills defined by Eisenberg & Berkowitz (1990): (1) *finding* information within an information source (browsing), (2) *engaging* information within an information source (viewing, listening, and reading), and (3) *extracting* information from an information source (notetaking).

Motivation Questionnaire. The Information Resource Attitude Survey (IRAS) (Small, 1992) was used to measure subjects' motivation in using a specific resource. Motivation is further defined as value (how interesting and relevant is the information and resource) and expectancy for success (amount of confidence in the resource and its information and how satisfied the user is with the information and resource). This survey, adapted from Keller's Instructional Materials Motivation Survey (1987), was used to assess subjects' motivation toward using a specific information resource (i.e. a book or an interactive videodisk program) to complete an assigned task.

The IRAS consisted of a 24-item Likert-type scale with two subscales of twelve items each related to value and expectancy. Subjects were required to rate their motivation toward the resource from 1 (not true) to 5 (very true). All items were identical for pre- and post-treatment instruments for print subjects and multimedia subjects, except for the words "book" and "multimedia" on both instruments and change in verb tense from pretest to posttest (future to past tense). Some examples from the pretest are:

"I expect that the information that I find in this book will be useful to me." (value)

"I believe the information will be presented in an exciting and stimulating way." (value)

"I believe that this book will be easy for me to use." (expectancy for success)

"I believe that I will have control over the type and amount of information I use in this resource." (expectancy for success)

A Cronbach coeffficient alpha was used to test the reliability of the motivation instrument. The overall reliability levels for the pretest was .91 and for the posttest was .95. The reliability levels for the two subscales were .73 (value pretest) and .87 (value posttest) and .74 (expectancy pretest) and .82 (expectancy posttest) which were deemed sufficiently high to consider both subscales reliable (Nunally, 1978).

Pattern Noting. When completing research tasks, learners access different types and amounts of information, as well as different subject matter. Therefore, there is little control over what should or will be learned and traditional tests (e.g. multiple choice) do not adequately assess learning in these situations. One method that has been advocated for assessing learning under these circumstances is a concept mapping approach called pattern noting.

Pattern noting is a technique used to assess both prior knowledge and learning by determining changes in knowledge structures (Jonassen, 1987). Pattern notes require the individual to free-associate with a topic that has been represented by a word or phrase within a box centered on a blank sheet of paper, by drawing lines containing related ideas (words, phrases, or sentences). Secondary ideas are linked to primary ideas and connections may be made by drawing a connecting line between any two terms that are perceived as related. Ideas may be represented as words, phrases, or complete sentences. Changes from pre-treatment to post-treatment pattern notes are interpreted as indicators of learning (Small & Grabowski, 1992).

The number of main terms the individual writes indicates the breadth of information that individual has associated with the given topic in memory, while the branch terms are

an indication of depth of knowledge. Links (connected terms) drawn between terms indicate perceived interrelatedness of terms (Jonassen, 1987). An example from the current study appears in Figure 1.

Place Figure 1 about here

Subjects

Eighty-nine middle school (grades 6, 7, and 8) students served as initial subjects for this study and were randomly assigned to one of the two treatments. An additional multimedia treatment group consisting of 36 adult graduate students at a large northeastern university was included to explore potential differences in results due to age of subjects. All subjects completed the pretest and posttest motivation scales and pattern notes. Each subject received the treatment individually while being observed by one of the researchers.

Treatment

A topic in the area of art was selected as the content area for the materials used in this study because this was thought to be an area in which subjects would likely have limited knowledge and the task would be considered relatively novel for all subjects. *Van Gogh Revisited*, (Voyager Company, 1988), a Hypercard-based program with video laserdisk, was selected for the multimedia treatment. This program contains text information with slides, photographs, graphics (timeline), and full motion video. The program requires two monitors, one for text information contained within the HyperCard stack and the other for nontext information contained on the videodisk, a format that facilitated observation of information location and use strategies. The program also offers an index as a "find" mechanism, a "catalog" which simulates a table of contents, and arrows that allow users to progress backwards and forwards one screen at a time which approximates browsing through the pages of a book. In addition, this program was selected because researchers believed that subjects would have little or no prior knowledge of the content.

The book *Vincent Van Gogh: Art, Life and Letters* (Zurcher, 1985, Rizzoli Publishers) was chosen as the print treatment because it was closest (except for full-motion video and audio) in formats, content, and amount and type of information to the multimedia resource. It contained full-page, full-color art prints opposite full-page text, a timeline, an index, and a table of contents. The vocabulary level used was deemed generally equivalent in both resources.

Procedures

Prior to the conduct of the study, all subjects were trained in use of multimedia hardware and software using a CD-ROM -based software package (*Compton's Multimedia Encyclopedia*) similar in formats (e.g. sound, moving images, color, graphics, still images, text) and functions (e.g. mouse-driven, buttons, icons) to the one used in the treatment. They were also trained in the pattern noting technique. Prior to the treatment, subjects were administered the motivation pre-treatment questionnaire and were asked to complete an initial pattern note on the life and art of Vincent Van Gogh to determine their prior knowledge of the topic.

Subjects were given the task of using an assigned resource (either book or multimedia) to gather information about the life and art of Vincent Van Gogh. All subjects were given a workspace in which they could work individually and undisturbed for 30 minutes. An observer sat with each subject and recorded all keystrokes and eye movements on the observation checklist. Immediately following the treatment, subjects were asked to complete a final pattern note and motivation post-treatment questionnaire.

RESULTS

This study investigated the information location and use activities, motivation, and learning patterns of subjects using either a print or multimedia resource to complete a research task. The dependent variables in this study were:

- number and type of information location and use activities
- responses on a 24-item motivation survey, and
- the number and type of post-treatment pattern noting terms.

Information Location and Use

Data obtained from the observation checklists were analyzed for amount and type of information location and use activities (finding, engaging, extracting). In a comparison of children's treatment groups using Scheffe's test, those using the multimedia resource performed significantly more finding ($F=8.1$; $p<.0001$) and engaging ($F=6.4$; $p<.0001$) activities but those using a print resource performed significantly more extracting activities ($F=22.6$; $p<.0001$) (see Table 1). Analyses that determined percentages of total activities in each category revealed that at least half of the activities in both treatment groups involved engaging activities. Print subjects spent about half their time divided between finding and extracting activities while multimedia subjects spent more time in engaging activities and most of the rest of their time in finding activities, browsing through the information.

Place Table 1 about here

A comparison of the two multimedia treatment groups found that adults performed significantly more finding and engaging tasks than children but not more extracting tasks (see Table 2). However, a closer look at the data by percentage of total activity revealed that the results were quite similar for both groups.

Place Table 2 about here

A further analysis of engaging activities by type of information (text or nontext) indicated that children in the multimedia treatment group engaged significantly more nontext information than children in the print treatment group but that both groups engaged a similar amount of text (see Table 3). However, an analysis by percentage of total information engaged revealed that about the same proportion of text (55%) and nontext (45%) was engaged by print subjects but three times as much nontext (75%) than text (25%) was engaged by children in the multimedia treatment. It is likely that the availability of video in the multimedia treatment contributed to this result.

Place Table 3 about here

A comparison of both multimedia groups revealed that although adults engaged significantly more of both text ($F=8.6$; $p<.0001$) and nontext ($F=5.8$; $p<.001$) than children, each group engaged a similar ratio of nontext to text (about 3-1) by percentage (see Table 4).

Place Table 4 about here

Motivation

Because the novelty effects of the multimedia treatment might have influenced motivation scores, all analyses were performed on the basis of pretest-posttest change

scores. An analysis of variance on IRAS scores indicated that there were no significant differences in total motivation or value subscale change scores between children's treatment groups. There was a significant decrease on the expectancy subscale for the print treatment group ($F=5.2$; $p<.02$). (See Table 5) Actual mean scores decreased from pretest to posttest and both subscales for print treatment subjects but increased on total test and value subscale for those in the multimedia treatment group. Multimedia treatment group had significantly higher total test means ($F=7.4$; $p<.05$) and value subscale ($F=8.4$; $p<.05$).

Place Table 5 about here

An analysis of variance for adult and children's multimedia treatment group scores found test mean scores were significantly higher for adults on total test and value subscale (see Table 6). An analysis of pretest to posttest change scores found adult change scores approached significance (decrease) on the expectancy subscale ($F=3.7$; $p<.06$). Actual scores showed a decrease on total test and expectancy subscale for adults and increased on total test and value subscale. Adult mean scores on the total test score means ($F=6.7$; $p<.05$) and value subscale ($F=19.9$; $p<.01$) were significantly higher than children's scores.

Place Table 6 about here

As they were leaving the treatment location, some adult subjects expressed frustration and uncertainty about the amount of information available for access when using a multimedia information system. Information overload may negatively affect ability to "integrate and cope with all that information...lead(ing) to dissatisfaction" (Cummings, O'Connell and Huber, 1976, p. 234). This phenomenon may have contributed to a lack of subjective certainty about the adequacy of the information search process or the information accessed, resulting in a perceived lack of closure.

Learning

For the children's treatment groups, two one-way analyses of variance of the posttest scores were conducted separately for grade level and gender and found no significant differences. Multivariate analysis of variance revealed no significant differences between treatment groups in terms of scores on the Stanford Achievement Test, 8th edition, Form J, a standardized achievement test. Therefore, posttest differences between treatment groups could be considered a function of treatment conditions. Pre-treatment and post-treatment pattern notes were analyzed for total number of terms, number of main terms (i.e., those connected to the topic term) and number of branch terms (i.e., those connected to the main terms).

An analysis of pattern notes for both children's treatment groups indicated no significant difference in total number of terms, main terms, and branch terms (see Table 7). A closer look at the proportion of main to branch terms by percentage showed about half of the terms were main and branch terms on both the pretest and posttest for both groups. However, further analysis by type of information (words, phrases, sentences) revealed that on the posttest, for children using a print resource, 25% of the terms they used were words while most (75%) were phrases and sentences while on the same test, 40% of the terms used by children in the multimedia group were words and a majority (60%) were phrases and sentences. However, although both groups had more words than phrases or sentences on the pretest, the print group used more phrases and sentences than words on the posttest while the multimedia group continued to use more words than phrases or sentences, although their percentages were much closer for all three types.

Place Table 7 about here

In a comparison of pattern notes for subjects in both multimedia treatment groups adults had a significantly higher number of terms on the pretest. A comparison of pretest and posttest results showed within-group increases (i.e., the total number of terms, main terms, and branch terms from pretest to posttest) for all treatment groups. As expected, adults used a significantly greater total number of terms ($F=3.8$; $p<.03$) and number of branch terms ($F=10.2$; $p<.0001$) while number of main terms approached significance ($F=2.5$; $p<.06$) on the posttest (see Table 8). Since adults had significantly higher scores for both pretest and posttest, further analyses of pretest to posttest change scores was conducted. They indicated a significant change for branch terms only ($F=22.77$; $p<.0001$) with an adult mean change score of +10.1 and children's mean change score of +2.8.

Place Table 8 about here

Additional analyses of the data were performed to determine the percentage of knowledge levels (i.e., main and branch terms) and knowledge representation (i.e., words, phrases, sentences) on both the pre-and post-treatment pattern notes. Results indicated that for knowledge representation, both groups showed an increase in percentage of phrases and sentences and a decrease in percentage of words. On the posttest, 40% of the terms used by children were words, while 60% were phrases and sentences, while for adults, 63% of the terms were words and 37% were phrases and sentences. For the levels subscales, adult subjects showed a larger decrease in main terms (42% to 26%) than children (53% to 50%) and a larger increase in branch terms (58% to 74%) than children (46% to 49%) from pretest to posttest. On the posttest, both children's groups had about the same percentage of main and branch terms on pretests and posttests but on the posttest, adults represented about 3/4 of their acquired knowledge as branch terms.

DISCUSSION

The primary research questions for this study explored the information location and use, motivation, and learning patterns for young and adult subjects. Subjects were given a research task using either a print or multimedia resource. Researchers recorded information location and use strategies (finding, engaging, extracting) on an observation checklist. The Information Resources Attitude Survey (IRAS) evaluated subjects' motives and values related to the resource used. A pattern noting technique was utilized to assess prior knowledge and learning outcomes.

More finding and engaging activities were performed by multimedia treatment groups than print treatment group. More extracting activities were performed by print subjects. The majority of activities were engaging activities for all groups. Subjects using the print resource located and used about the same amount of text and nontext information while those using the multimedia resource located and used about three times as much nontext as text. Although adults engaged significantly more nontext than children, the ratio of nontext to text was about the same for both multimedia groups.

One adult subject commented after the treatment that with a book, she could tell how much information she had *not* accessed but with multimedia because she could move around freely, she did not know how much information she had accessed, if she had accessed all the information, and felt dissatisfied because she had not achieved closure. Closure has been considered as a possible contributing factor to satisfaction (Small & Venkatesh, 1994).

Results indicated that both children and adults have about the same motivation toward both resources. Actual differences indicated that motivation increased for children

following the multimedia treatment but not for adults nor for children using a print resource.

As in previous studies, book users, although they have much more training and experience in using print materials, learned no more than those using a computer-based multimedia resource. There were some differences in learning patterns in ways knowledge was represented ; i.e., multimedia subjects used a greater percentage of single word terms while print subjects used a greater percentage of phrases and sentences. This may be the result of a more fragmented engagement of information when using a multimedia resource since those subjects tended to do more browsing , reading, and viewing. Future research may reveal that users of multimedia resources spend less time on any one screen and more time moving around in the information, leading to more of a "sound bite" learning experience. These results indicate the need for better methods that assess knowledge acquisition in situations where much of the information learned is visual and/or auditory. Text-based, verbal methods may not adequately measure learning in these situations. Perhaps more qualitative methods would be appropriate.

Some differences between adult and child subjects may be attributed to relevance of the task. In addition, children were randomly assigned, while adults were a convenience sample.

Another interesting outcome was that subjects in the multimedia treatment group repeated more inaccurate information (e.g., "Vincent Van Gogh invented the helicopter" or "Vincent Van Gogh painted the Mona Lisa") on both pattern notes, perhaps indicating that they found no information to refute these ideas, therefore they considered them accurate.

Research that explores both affective and cognitive outcomes from using single format and multiple format (multimedia) information resources may help designers of multimedia resources and teachers provide appropriate guidance for their use. The models for conducting independent research tasks using print resourcews may not be appropriate for the use of multimedia research tools. This has implications not only for multimedia designers, but for teachers and school library media specialists who are charged with the responsibility of preparing our future researchers.

(Figures and tables found in Appendix G)

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